

A new fossil green lacewing (Neuroptera: Chrysopidae) from the early Eocene Driftwood Canyon, Canada

S. BRUCE ARCHIBALD¹ & VLADIMIR N. MAKARKIN^{2,3}

¹Department of Biological Sciences, Simon Fraser University, 8888 University Drive, Burnaby, BC, Canada V5A 1S6; Museum of Comparative Zoology, Cambridge, MA, USA; Royal BC Museum, Victoria, BC, Canada V8W 1A1.

²Federal Scientific Center of the East Asia Terrestrial Biodiversity, Far East Branch of the Russian Academy of Sciences, Vladivostok, 960022, Russia

³Corresponding author. E-mail: vnmakarkin@mail.ru

Abstract

Lithochrysa borealis **sp. nov.** (Neuroptera: Chrysopidae: Nothochrysinae) is described from the early Eocene locality at Driftwood Canyon (British Columbia, Canada). The forewing venation of the new species is similar to that of the late Eocene *L. wickhami* (Cockerell, 1914) from Florissant (Colorado, U.S.A.), but is distinguished from it by a slightly longer intramedian cell and distinctly longer branches of RP to CuA between the pseudocubitus and the posterior margin.

Key words: Neuroptera, Chrysopidae, Nothochrysinae, new species, Eocene, Driftwood Canyon

Introduction

The diversity of Eocene Chrysopidae is rather high, with 21 currently described species (see list in Archibald & Makarkin 2015). Of these, fifteen are known from North America, eight from the late Eocene Florissant Formation in Colorado (U.S.A.) (Carpenter 1935; Adams 1967), and seven from the early Eocene Okanagan Highlands series of localities (Archibald *et al.* 2011) at Driftwood Canyon and McAbee in southwestern British Columbia, Canada, and at Republic in north-central Washington, U.S.A. (Makarkin & Archibald 2013).

Previously, we reported a chrysopid specimen from Driftwood Canyon which, although it undoubtedly represented a new species, we declined to name by its unclear systematic position, and so treated it as Nothochrysinae species A (Makarkin & Archibald 2013). Recently, however, examination of fossils of the family from Florissant (V. Makarkin, G. Antell, B. Archibald, in preparation) has shown that it is closely related to species of *Lithochrysa* Carpenter 1935. We are now able to describe and name a new species of that genus based on this specimen.

Material and methods

We describe this species based on a single fossil specimen from an exposure of lacustrine shale in Driftwood Canyon Provincial Park, the northernmost of the Okanagan Highlands sites, near the town of Smithers, British Columbia. It is estimated to be 51.77 ± 0.34 million years old (J. Mortensen & B. Archibald, current research).

Terminology generally follows that of Kukalova-Peck & Lawrence (2004), as modified by Yang *et al.* (2012, 2014), except for that of wing spaces and details of venation (e.g., veinlets, traces), which follows Oswald (1993).

Abbreviations: AA1–AA3, first to third branches of the anterior Analis; CuA, anterior Cubitus; CuP, posterior Cubitus; *im*, intramedian cell; MA and MP, anterior and posterior branches of the Media; Psc, Pseudocubitus; Psm, Pseudomedia; RA, anterior Radius; RP, posterior Radius; RP1, proximal-most branch of anterior trace of RP; ScP, Posterior Subcosta. Crossveins are designated after the longitudinal veins which they connect and are numbered in sequence from the wing base, e.g., 1r-m, first (proximal-most) crossvein connecting R/RP and M/MA; 1im, first (proximal-most) crossvein between MA, MP.

Institutional abbreviations: RBCM, Royal British Columbia Museum, Victoria, British Columbia, Canada.

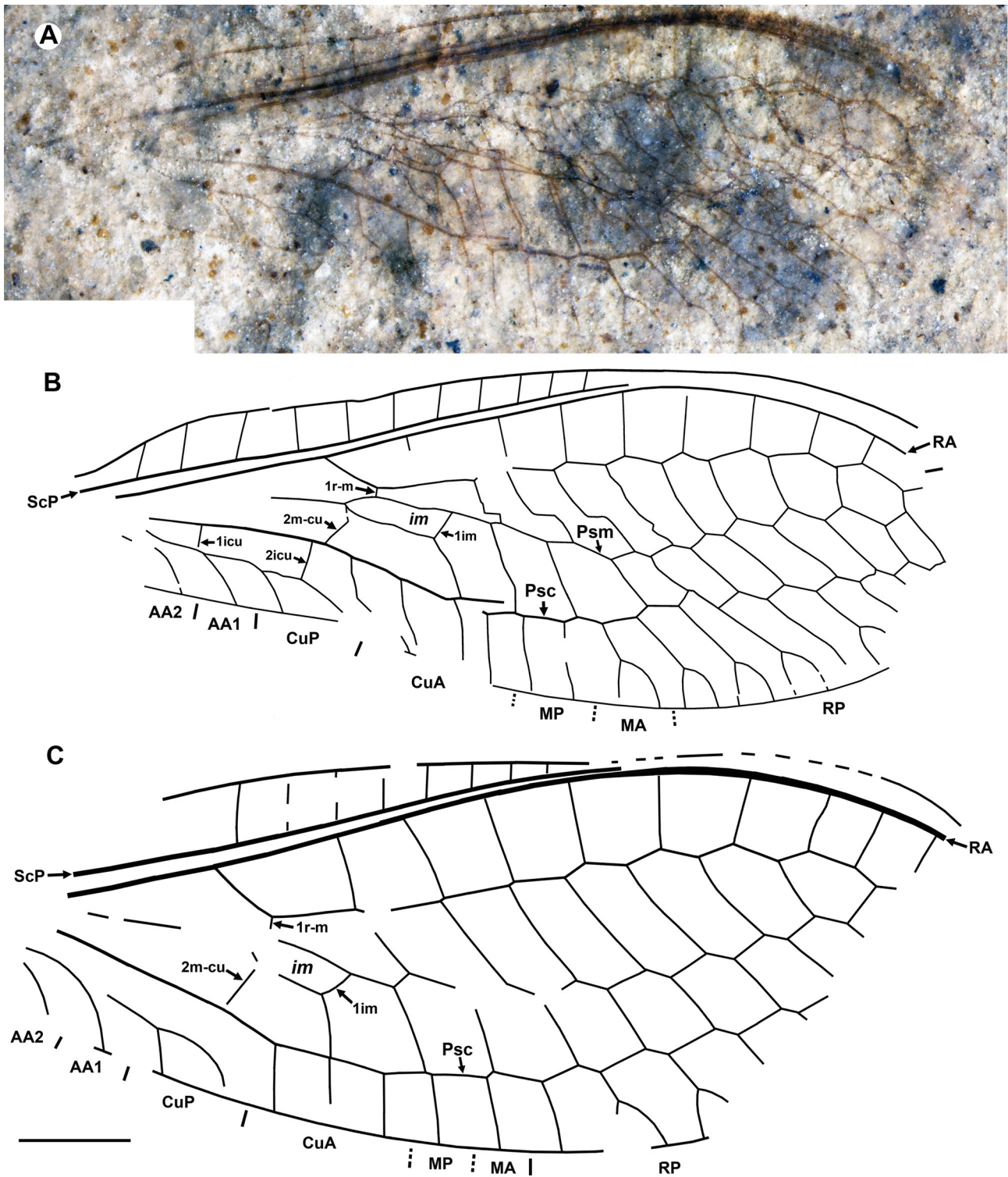


FIGURE 1. Wings of *Lithochrysa*. A, B, *L. borealis* sp. nov., holotype RBCM.EH2012.003.0007.001. A, specimen as preserved, a crumpled forewing overlaying a partial hind wing; B, forewing venation (hind wing not shown; see Makarkin & Archibald 2013: Fig. 22.3); C, *L. wickhami* (Cockerell, 1914), holotype MCZ 4499, venation of one of the forewings. Scale bar = 1 mm (all to scale)

Systematic paleontology

Order Neuroptera Linnaeus, 1758

Family Chrysopidae Schneider, 1851

Subfamily Nothochrysinæ Navás, 1910

Genus *Lithochrysa* Carpenter, 1935

Lithochrysa borealis sp. nov.

Figs 1A, B

Nothochrysinæ species A: Makarkin & Archibald 2013: 139, Fig. 22.

Diagnosis. May be distinguished from other species of *Lithochrysa* by distinctly proximal position of crossvein 2m-cu; from *L. wickhami* by slightly longer intramedian cell; by distinctly longer branches of RP to CuA between Psc, posterior margin (i.e., Psc located closer to posterior wing margin in *L. wickhami* than in *L. borealis* sp. nov.).

Description. Forewing 8.2 mm long as preserved (estimated complete length 8.7 mm), ca. 3 mm wide. Costal space moderately broad. Subcostal veinlets simple, widely spaced. Pterostigma indistinct. Subcostal space quite narrow; subcostal crossveins not detected. Terminal portions of ScP, RA not preserved. RA space broad, with nine preserved crossveins, rather regularly spaced. RP originates far from wing base (at about a third estimated wing length); zigzagged, with eight–nine branches. RP1, MA connected by short crossvein at anterior gradate series (i.e., basal-most crossvein in anterior gradate series present). Basal crossvein 1r-m short, connecting RP, *im* in proximal half. M forked slightly distad origin of RP. MA, MP slightly divergent toward Psc. Crossvein 1im (distal end of cell *im*) moderately long. *im* elongate, narrow (three times longer than wide). Psm poorly developed. Long crossvein 2m-cu connects *im*, CuA at fork of M (or slightly distad it). CuA apparently with four simple branches. Psc rather well developed. CuP deeply forked. Two crossveins between CuA, CuP; 2icu connecting CuA, anterior branch of CuP. AA1 simple (appears fused with CuA basally). AA2 probably simple. Two gradate series of crossveins; inner series arranged in unbroken, even curve; with nine crossveins.

Hind wing very crumpled, poorly-preserved, 6.5 mm long as preserved (estimated complete length ca. 7.5 mm). Crossveins in RA space regular; two gradate series of crossveins; branches of RP widely spaced. Other details unclear.

Type material. Holotype RBCM.EH2012.003.0007.001 (part only), property of BC Parks (British Columbia Ministry of Environment), deposited in the collections of the RBCM; a rather poorly-preserved, crumpled and overlapping forewing and hind wing.

Locality and horizon. Driftwood Canyon, British Columbia, Canada (public exposure near top); early Eocene.

Etymology. The specific epithet *borealis* (neuter *boreale*) is Latin for “northern”, as the new species is the northern occurrence of the genus.

Discussion

Carpenter (1935) assigned two species to the genus *Lithochrysa*, both from Florissant: *Lithochrysa wickhami* (Cockerell, 1914) and *L. concinnula* (Cockerell, 1909) (*L. wickhami*, Fig. 1C, other species will be figured in a revision of Florissant Chrysopidae in preparation: Makarkin, Antell, Archibald). A third species, *Palaeochrysa ferruginea* Cockerell, 1909, also from Florissant, was considered by Carpenter (1935) to be a synonym of *L. concinnula*, but this needs confirmation, as their intramedian cells are differently shaped. Adams later (1967) synonymized the genus with *Palaeochrysa* Scudder, 1890; however, we examined the type species of *Palaeochrysa* (*P. stricta* Scudder, 1890) and *Lithochrysa* (*L. wickhami*), and found sufficient reason to consider both to be valid, separated by, e.g., the inner gradate series of crossveins is arranged in an unbroken, even curve in *Lithochrysa* (see Fig. 1C), but is distinctly shifted anteriad at about 2/3 wing length in *Palaeochrysa*.

The forewing venation of *Lithochrysa borealis* **sp. nov.** is most similar to that of *L. wickhami*, but is easily distinguished from it as indicated in the diagnosis (see Figs 1B and 1C). *L. concinnula* and *Palaeochrysa ferruginea* were incompletely described, and given current information, only the position of crossvein 2m-cu (see diagnosis) and the shape of the intramedian cell in these species may be compared with those of the new species with confidence (see Cockerell 1909: Figs 5, 6). The new species differs from these by the more proximal position of crossvein 2m-cu; and further from *L. concinnula* by a shorter crossvein 1m closing *im*, so that MA and MP are convergent within *im* in that species, but is slightly divergent in the new species.

Lithochrysa borealis **sp. nov.** is the third species of Chrysopidae described from Driftwood Canyon, along with *Pseudochrysopa harveyi* Makarkin & Archibald, 2013 and *Archaeochrysa sanikwa* Archibald & Makarkin, 2015. It is noteworthy that two of these three genera also occur at Florissant some 18 million years later (*Lithochrysa* and *Archaeochrysa* Adams, 1967).

Acknowledgements

We thank Gwen Antell (Florissant Fossil Beds National Monument, Colorado, U.S.A.) for providing us with photographs of the holotypes of *Palaeochrysa stricta* and *Lithochrysa wickhami*, and the people of BC Parks, in particular John Howard, for allowing and expediting fieldwork at Driftwood Canyon. S.B.A. thanks Rolf Mathewes (Simon Fraser University) for facilitating research. The study is supported by Grant Nos. 16-04-00053 and 14-04-00649 of the Russian Foundation for Basic Research to V.N.M.

References

- Adams, P.A. (1967) A review of the Mesochrysinæ and Nothochrysinæ (Neuroptera: Chrysopidae). *Bulletin of the Museum of Comparative Zoology*, 135, 215–238.
- Archibald, S.B., Greenwood, D.R., Smith, R.Y., Mathewes, R.W. & Basinger, J.F. (2011) Great Canadian Lagerstätten 1. Early Eocene Lagerstätten of the Okanagan Highlands (British Columbia and Washington State). *Geoscience Canada*, 38, 155–164.
- Archibald, S.B. & Makarkin, V.N. (2015) A new species of *Archaeochrysa* Adams (Neuroptera: Chrysopidae) from the Early Eocene of Driftwood Canyon, British Columbia, Canada. *Canadian Entomologist*, 147 (4), 359–369.
<https://doi.org/10.4039/tce.2014.53>
- Carpenter, F.M. (1935) Tertiary insects of the family Chrysopidae. *Journal of Paleontology*, 9, 259–271.
- Cockerell, T.D.A. (1909) Two fossil Chrysopidae. *Canadian Entomologist*, 41, 218–219.
<https://doi.org/10.4039/Ent41218-7>
- Cockerell, T.D.A. (1914) New and little-known insects from the Miocene of Florissant, Colorado. *Journal of Geology*, 22, 714–724.
<https://doi.org/10.1086/622186>
- Kukalová-Peck, J. & Lawrence, J.F. (2004) Relationships among coleopteran suborders and major endoneopteran lineages: evidence from hind wing characters. *European Journal of Entomology*, 101, 95–144.
<https://doi.org/10.14411/eje.2004.018>
- Linnaeus, C. (1758) *Systema naturae per regna tria naturae secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis. Vol. 1. 10th Edition*. Salvii, Holmiae, 824 pp.
- Makarkin, V.N. & Archibald, S.B. (2013) A diverse new assemblage of green lacewings (Insecta: Neuroptera: Chrysopidae) from the Early Eocene Okanagan Highlands, western North America. *Journal of Paleontology*, 87, 122–145.
<https://doi.org/10.1666/12-052R.1>
- Navás, L. (1910) Crisópidos (Ins. Neur.) nuevos. *Brotéria (Zoológica)*, 9, 38–59.
- Oswald, J.D. (1993) Revision and cladistic analysis of the world genera of the family Hemerobiidae (Insecta: Neuroptera). *Journal of New York Entomological Society*, 101, 143–299.
- Schneider, W.G. (1851) *Symbolae ad monographiam generis Chrysopae*, Leach. Hirt, Vratislaviae, 178 pp.
- Scudder, S.H. (1890) The Tertiary insects of North America. *Report of the United States Geological Survey of the Territories*, 13, 1–734, 28 pls.
- Yang, Q., Makarkin, V.N. & Ren, D. (2014) Two new species of *Kalligramma* Walther (Neuroptera: Kalligrammatidae) from the Middle Jurassic of China. *Annals of the Entomological Society of America*, 107, 917–925.
<https://doi.org/10.1603/AN14032>
- Yang, Q., Makarkin, V.N., Winterton, S.L., Khramov, A.V. & Ren, D. (2012) A remarkable new family of Jurassic insects (Neuroptera) with primitive wing venation and its phylogenetic position in Neuropterida. *PLoS ONE*, 7 (9), e44762.
<https://doi.org/10.1371/journal.pone.0044762>